Communications Measurement

M 1450E

OPERATING INSTRUCTIONS
FOR
MODEL M1450E
Variable Frequency Generator

CML

MP MASTER
MA30172

WARRANTY

C. M. L., Inc. warrants each instrument manufactured by it to be free from defects in material and workmanship. Our liability under this warranty is limited to repairing or replacing any instrument or part thereof, (except electron tubes and fuses) which shall, within one year after delivery to the original purchaser, be returned to us with transportation charges prepaid, prove after our examination to be thus defective. Our warranty for this instrument is rendered void if the unit has been modified, unless such changes have been made in accordance with written instructions received from C. M. L., Inc.

C. M. L., Inc. reserves the right to discontinue instruments without notice, and to make modifications in design at any time without incurring any obligation to make such modifications to instruments previously sold.

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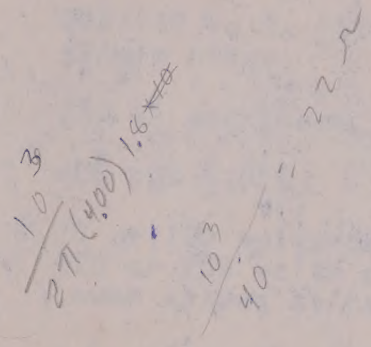
OPERATING INSTRUCTIONS AND SERVICE NOTES
FOR
MODEL MI450E
VARIABLE FREQUENCY GENERATOR



COMMUNICATION MEASUREMENTS LABORATORY, INC.
350 Leland Avenue Plainfield, New Jersey
Telephone: PLainfield 4-5502

OPERATING INSTRUCTIONS AND SERVICE NOTES FOR MODEL MI450E VARIABLE FREQUENCY GENERATOR

I. GENERAL

The CML Model MI450E is an electronic generator which provides a source of well regulated, low distortion, three phase power.

The total maximum rated output for the three phases is 750 VA or 250 VA per phase.

II. SPECIFICATIONS

Input:	208/230 volts ±5%, 60 cycle, single phase.
Output Power:	250 VA per phase, 750 VA total.
Frequency:	400 cps ±.05%
Voltage Outputs:	70 or 120 volts per phase, nominal 120 or 208 volts phase to phase. Lower values at reduced power.
Voltage Stability:	±.5 for ±5% line change.
Optimum Load Resistance:	58 ohms per phase
Phase Angle Stability:	±1.5%
Output Voltage Regulation:	Better than 1% from no load to full load. Setable to zero.
Total Harmonic Distortion:	1.0% maximum

III. CONTROLS AND ADJUSTMENTS

A. Front Panel

1. Gain: This control is essentially a "Master Gain" control, used to initially adjust the desired output voltage level of all three phases.

2. Trim Phase 2 and 3: Allows a "fine" adjustment of phase 2 and 3 output to equal that of phase 1.

3. Meter Switches: Allows selection of meter function as desired. Reading individual output tube plate currents and output voltages for each phase.

II. CONTROLS AND ADJUSTMENTS

A. Front Panel (continued)

4. Bias Adjust: Six controls are provided, one for each final amplifier tube. The plate current meter on the panel reads the individual plate currents of these tubes. Bias adjustment should be made with no signal and it should be 30 ma per tube. The gain control on the front panel must be completely counter-clockwise (Off) during this adjustment. The bias controls are located behind the front panel and are accessible by removing the plugs from the holes provided for these adjustments.

5. Frequency Range Switch and Frequency Dial: Used only on variable frequency models. Controls are self-explanatory.

B. Top of Control Chassis

1. Phase Angle Adjust: Adjusts the phase shifting networks of Phases 2 and 3 to provide the required angular displacement between all phases. (See text on "Alignment", Page 7.)

C. Rear Panel Low Voltage Supply

1. B+ Adjust: Factory adjusted to give +400 volts D.C. (regulated) from the low voltage power supply to the appropriate circuits. A test jack is located adjacent to the adjustment potentiometer.

D. Rear of Power Amplifier Chassis

1. Regulator controls (positive feedback): These controls are adjusted to provide output voltage "no-load" to "full-load" regulation. Adjustment is covered under "Regulator Control Adjustment" (Positive Feedback).

IV. TUBE COMPLEMENT

Variable Frequency Units	(V-201)	6AN8	Wien Bridge Oscillator
	V-202	6922	90° Phase Shifter
	(V-203	6922	120° Phase Shifter
Fixed Frequency Units	V-101	6BC8 or 6922	Band pass and 120° Shifter Stage

PHASE 1	PHASE 2	PHASE 3	TUBE	FUNCTION
V-1, 2	V-3, 4	V-5, 6	6AN8	Amplifier Driver
V601,602	V-603,604	V-605,606	7094	Power Amplifier

TUBE COMPLEMENT (continued)

POWER SUPPLY CHASSIS

V-301	5R4	Low Voltage Rectifiers
V-303	6AS7	+400 V Regulated Supply "Pass" tubes
V-304	½6AN8	+400 V Regulated Supply Control Amplifier
V-306	OB2	+400 V Regulated Supply References
V-303	½6AN8	+ 30 V Regulated Supply "Pass" tubes
V-302	OB2	Bias Supply Regulator
V-401, 402	3B25	High VoltageRectifiers

. CIRCUITRY

A. Variable Frequency Oscillator

The Variable Frequency Oscillator consists of a Wien Bridge oscillator followed by a phase shifting circuit to produce three signals each displaced by 120°.

The output of the Wien Bridge oscillator is fed into a phase shifting circuit whose output is tuned by identical RC components to those in the Wien Bridge so that it produces a 90° phase shift between the input and the output voltages. The original signal and the 90° displaced signal are fed into a phase shifter tube. Signals are mixed in two RC networks which are adjusted to produce 120° plus and 240° plus from the original signal.

B. Fixed Frequency Oscillator

The Fixed Frequency Oscillator may be either the Wien Bridge type or tuning fork type. In either case, the oscillator output is fed through a Master Gain control to a band pass amplifier whose output is used to drive a transformer with phase shifting controls in the secondary. The phase displaced signals derived at the secondary of said transformer are then used to excite the three voltage amplifiers.

V. CIRCUITRY (continued)

C. Voltage Amplifier

The voltage amplifier tube, a 6AN8, has its grid driven by the signal from the phase shifter. The output of the pentode section of the 6AN8 is DC coupled to the grid of the cathode follower triode section of the same tube. The output of the triode section cathode follower is AC coupled to the grid of the first of the push-pull power amplifier tubes.

The Voltage Amplifier tube working in conjunction with another 6AN8 form a self-balancing, single ended to push-pull amplifier in which phase inversion is accomplished. With reference to this second 6AN8, the output of the pentode section is again DC coupled to the grid of the triode section. The triode acting as a cathode follower has its output AC coupled to the grid of the second tube of the push-pull power amplifier tube. These tubes are designated V-1 and V-2; V-3 and V-4; and V-5 and V-6.

D. Power Amplifier

The Power Amplifier consists of a pair of 7094's for each phase, driven by the voltage amplifier tubes. The output of the power amplifier tubes is fed into a transformer which has dual secondary windings. The first of the two windings serves as the power output winding. The second winding is used to provide negative feedback to prevent the deterioration of the output wave shape and to lower the dynamic impedance of the generator. This serves to improve the regulation characteristics of the generator. The power amplifier tubes are designated as V-601 and V-602; V-603 and V-604; V-605 and V-606.

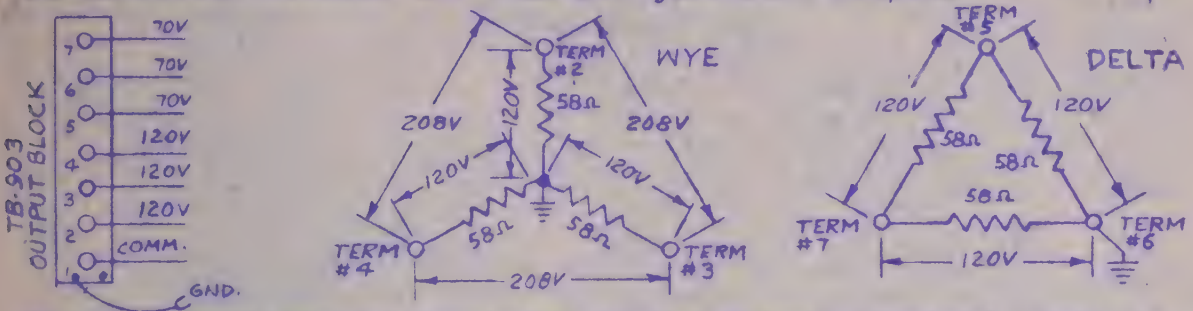
Positive feedback is also used to control the output voltage regulation from no load to full load. The controls used to adjust the regulation are mounted on the rear of the power amplifier chassis. Their use will be described under "Operation".

I. OPERATION

The power source from which this unit is designed to operate is 208/230volts, 60 cps, single phase. An autotransformer supplies the LV power supply and all filaments. The plate transformer of the HV power supply is tapped to accommodate various values of line voltage. These taps are plainly stamped for proper identification, and the movable tap should be placed on the terminal nearest that of the input power line valve.

The connections on the three prong male plug provided on the line cord are such that the two "outsides" are the 230 volt line and the third (odd) prong is"ground". Be sure that a good solid ground is provided and connected in the receptacle before attempting operation of this unit.

To properly test this generator, a three phase four wire resistive load should be provided. This load may consist of suitable wattage, 115 volt lamps connected as shown on the schematic and below. In the Wye configuration, a three pole single throw switch should also be connected between the load and generator output.



The lamp bank may be connected to the output terminal block in exactly the sequence shown from bottom to top connecting from left to right on the terminal block when facing it. This terminal block is located on the lower left hand side of the cabinet when looking in the rear door. Terminals 2, 3 and 4 are 120 volt taps on phases 1, 2 and 3, respectively. Terminal #1 is not grounded but is a phantom neutral connection and may or may not be grounded as desired, by using the grounding strap. NOTE: Either the common when wye connected or one leg when delta connected must be grounded to protect personnel in case of output transformer failure.

The Plate switch should be in the "off" position and the Gain Control at its minimum output, or fully counter clockwise position. Place the circuit breaker in the up position (ON). Check for proper blow and filament operation.

After a time delay of approximately 30 seconds, the thermal time delay relay protecting the high voltage rectifier filaments will close.

Now set the Plate or hi-voltage switch to the ON position. This will apply plate and screen voltages to the power amplifier tubes. The plate currents should now read approximately 30 ma per tube on the panel meter. If they do not, adjust the bias controls for each tube, located and identified on the front panel.

The Master Gain control should now be advanced until the panel voltmeter (in the individual phase voltage position) reads the desired output level.

With all phases balanced at 120 volts output, check the phase to phase voltage. If the phases are displaced by 120 degrees, the voltage will be 208 volts at each position. Should the voltages be greater than 3 volts removed from 208, it is a sign that the phase angle separation between phases is out of specification tolerance (Refer to the Alignment section if this should be the case). The generator may be checked for regulation once the output voltages and phase angles are balanced by removing and applying the load while observing the output voltage at each phase. If out of tolerance refer to the Alignment section. The generator is ready for general use once the above checks are completed satisfactorily.

I. POWER OUTPUT AND LOAD ADJUSTMENT

Rated output power of 250 VA per phase will be produced only when the load impedance is properly matched to the output tube impedances by means of the output transformer. At other values of load impedances some sacrifice of efficiency and power will be required. Loads, then, of different impedance may be used but at reduced power taking care when impedance mismatches occur, not to overload the output tubes. Overload is indicated by the plate current readings which should not exceed 220 ma per tube at rated load.

Power approaching that available at the rated volt level can be obtained at other voltage levels by the use of transformers or auto-transformers which have the required turns ratio. Regulation and waveform may deteriorate somewhat, but these effects should not be severe for well designed transformers.

The Model M-1450-E Generator is designed to operate loads of either the four wire "wye" or three wire "Delta" configuration. A study of the manual and schematic showing the output terminals arrangement should be consulted for proper connection of the two configurations. The panel voltmeters are tied to the 120 volt taps and when indicating same, the 70 volt taps will be at their correct voltage.

I. OSCILLATOR-PHASE SHIFTER ALIGNMENT

A. Variable Frequency Units

An oscilloscope, frequency measuring instrument, AC Vacuum Tube Voltmeter, and phase shifter meter are necessary to properly complete the alignment of the oscillator and phase shift networks.

The oscillator is first aligned, then the 90° shifter, last the 120° shifting networks. This order must be followed if a complete alignment is attempted.

The generator should be warmed up for at least 20 minutes before starting the alignment to insure stability.

An AC VTVM placed at the output of the oscillator should indicate approximately 7.0 volts. Place the scope or high input impedance frequency meter at this same point. (The Lissajous pattern technique for determining frequency with the scope is used if a frequency meter is not available.) Set the generator frequency dial at the high end of one of the frequency ranges. Adjust the oscillator calibration trimmers equally until this frequency is indicated on the frequency meter (or scope). Set the dial at the low end of this same frequency band and observe the frequency meter reading. If the dial pointer and the frequency meter reading do not agree, loosen the dial knob where it is attached to the gauged tuning capacitors and "slip" the knob until the pointer is reading the correct frequency. Lock the shaft and recheck the high end

of the dial, and readjust the trimmers if necessary, then recheck the low end. Repeat this procedure until the desired accuracy is obtained. The other ranges should fall into line unless their particular frequency determining resistors are out of tolerance.

B. Wien Bridge Fixed Frequency Units

No adjustments are necessary other than setting the oscillator to the desired frequency where a trimmer is provided.

PHASE ANGLE ADJUSTMENT

90° -- Variable Frequency Units

The 90° shifter must be set up using a phase shift meter. This circuit ordinarily will not need adjustment, unless the components have been changed therein, and should be left as is. If adjustment is needed, connect the phase meter at pin 3(V-104)for the reference voltage and at pin 8 for the shifted voltage. The object here is to adjust C-160 to the point where a minimum shift occurs when the oscillator is turned through its range. The phase meter should read very close to 90° when the proper adjustment is found.

120° -- Fixed or Variable Frequency Units

Proper operation of this generator as a three phase unit will be accomplished only if the angular displacement between the three phases is 120°. This adjustment has been made at the factory and normally will require no further adjustment. However, if adjustment becomes necessary, it can be accomplished in the following manner:

Connect the generator in the four wire "wye" configuration and ground the common terminal (pin 1) to the cabinet. Set the output voltage of each phase to 115 volts. The load should be balanced and should draw at least 200 watts. Connect the phase meter (or other phase measuring equipment) between phase one and two with common to ground. Adjust the 120 degree control for phase two until 120 degrees is read on the phase meter. Connect the phase meter between phase one and three and adjust the 120 degree control for phase three until 120 degrees is read on the phase meter. Connecting the meter between phase two and three should show a reading of 120 degrees if the above adjustments were properly made. A few repeat adjustments may be necessary to bring the phase angles within tolerance.

The 120° phase angle controls may be adjusted at any time without affecting either the oscillator or 90° shifter. It is also permissable to readjust these controls at any time precise separation of phase angle is required at any preset frequency.

REGULATOR CONTROL ADJUSTMENT (positive Feedback)

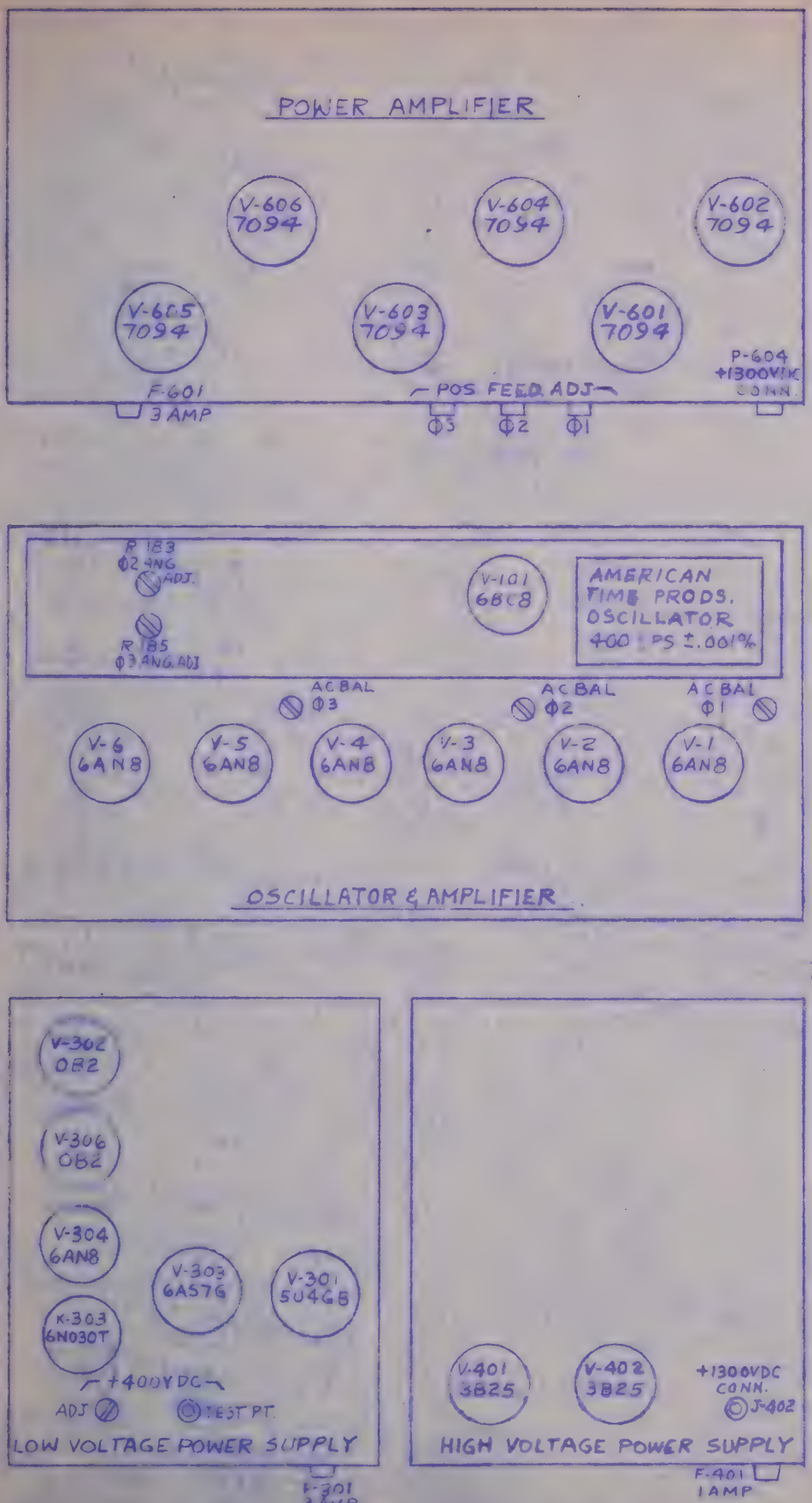
One control is used to set each phase. They are located on the rear apron of the power amplifier chassis and identified. The controls will have different settings for generator operation into "Delta"and "Wye" loads.

Excellent regulation may be had by slight adjustment of these controls, the object being to equalize the"full-load"voltage,using the positive feedback controls,to the"no-load" voltage (set by the Gain Controls).

PRECAUTIONS

Before turning the High Voltage on or off be sure the Gain Control is fully counter-clockwise (off). To leave it turned up places undue stress on the generator and should be avoided.

Do not attempt to draw full VA rating from the generator with loads presenting a poor power factor. The VA rating should be reduced when power factor is less than .7. A good "rule of thumb" is to multiply the maximum VA by the power factor present to obtain the maximum allowable (i.e., 300 VA x .5 P.F.= 150 VA).



MODEL 1450E
TUBE LAYOUT

REVISIONS			
SYM.	DESCRIPTION	DATE	APPROVAL
25	SERIAL # 185 ONLY	4-17-62	

OSCILLATOR

AMPLIFIER

POWER AMPLIFIER

LOW VOLTAGE POWER SUPPLY

METER PANEL

OUTPUT XMFR CONNECTIONS TO OUTPUT TERM BLOCK AND VOLTAGES.

NOTE;
1. ALL DC AND AC VOLTAGES MEASURED WITH A VTVM WITH RESPECT TO CHASSIS GROUND.
2. GAIN CONTROL IS FULL COUNTER-CLOCKWISE.
3. GAIN CONTROL ADVANCED TO GIVE 250 WATTS 120 VOLTS AT THE OUTPUT OF GENERATOR AT EACH PHASE.
4. * COMPONENT VALUE SELECTED IN TEST.

NEXT ASSY.	USED ON	REQ.	PART NO.	DESCRIPTION	MATL	MATL SPEC	CODE NO.
	1450E 1141-1						

LIST OF MATERIAL

APPLICATION

UNLESS OTHERWISE SPECIFIED, ALL DIMENSIONS ARE IN INCHES.
TOLERANCES-
DEC. ± .005 FRAC. ± 1/64
ANGLE ± 1/2°
FINISH-

	CML	NAME	DATE
DRAWN		JFZ	4-12-62
CHECKED			4-17-62
ENG. APP.			
APPROVAL			

MODEL 1450 GENERATOR SCHEMATIC

SCALE

COMMUNICATION MEASUREMENTS LABORATORY, INC.
380 LELAND AVENUE, PLAINFIELD, N. J.

FOR RECORD ONLY
ISSUE # 25- SERIAL # 185 ONLY

D-1450-50

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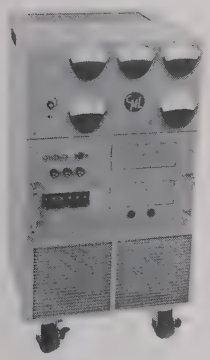
POWER AMPLIFIERS

BULLETIN NO. SPG 67

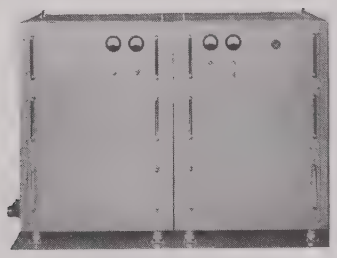
THE *New* COMPACT "SPG" SERIES

WIDE BAND POWER AMPLIFIERS for AUDIO and ULTRASONIC TESTING

- 1KVA TO 200KVA
- AIR COOLED & VAPOR COOLED MODELS



MODEL A5K
5KVA OUTPUT
33"H x 17"W x 17"D



MODEL A20K
20KVA OUTPUT
48"H x 68"W x 24"D
(Unit shown with special base for shipboard installation)

- IDEAL FOR CW AND PULSED DUTY
- ±0.5 DB FREQUENCY RESPONSE
- INSTANTANEOUS OVERLOAD PROTECTION WITH FRONT PANEL RESET
- LOW DISTORTION
- FULL POWER INTO REACTIVE LOADS
- RUGGED CONSTRUCTION FOR MARINE OR AIR-BORNE INSTALLATIONS

APPLICATIONS

SONAR TESTING — HIGH INTENSITY ACOUSTIC SYSTEMS — VIBRATION TEST
PLASMA TUBES — INDUSTRIAL PROCESS CONTROL — INDUCTION HEATING

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SPG SERIES — WIDE BAND POWER AMPLIFIERS

MODEL	OUTPUT POWER KVA	LOAD POWER FACTOR RANGE AT RATED KVA	STANDARD OUTPUT IMPEDANCE TAPS OHMS	*CABINET DIMENSIONS H x W x D INCHES	TYPE OF COOLING
A1K	1KVA	±0.4 to Unity	4/16/36/64/144/576	25 x 19 x 22	FORCED AIR
A2K	2	±0.4 to Unity	4/16/36/64/144/576	25 x 19 x 22	
A5K	5	±0.4 to Unity	100/300/500/700	33 x 17 x 17	
B5K	5	±0.1 to Unity	8/32/72/128/288/1152	45 x 24 x 24	
A10K	10	±0.1 to Unity	16/64/144/256/576/2304	48 x 68 x 24	
A20K	20	±0.3 to Unity	16/64/144/256/576	48 x 68 x 24	
VA30K	30	±0.1 to Unity	16/64/144/256/576	72 x 72 x 36	VAPOR COOLED
VA50K	50	±0.4 to Unity	16/64/144/256/576	72 x 72 x 36	
VA100K	100	±0.1 to Unity	16/64/144/256	2 sections, ea.: 90 x 72 x 57	
VA200K	200	±0.1 to Unity	16/64/144/256	3 sections, ea.: 90 x 72 x 57	

*Models A1K and A2K are available as standard 19" rack mount models or as bench models. All other models are furnished complete in cabinet enclosures. Models A5K and B5K include casters.

SPECIFICATIONS — STANDARD SPG SERIES

OUTPUT FREQUENCY: Standard full power frequency range is 100-10,000 cps. Other frequency ranges between 5 cps and 200KC are available on a custom basis.

OUTPUT CONFIGURATION: 2 wire floating; model A5K (only) 2 wire, one side grounded.

DUTY CYCLE: Continuous duty at full rated output power. Please consult CML for pulsed or intermittent duty ratings.

FREQUENCY RESPONSE: ±0.5 db, 100-10,000 cps.

HARMONIC DISTORTION: Less than 3%, 100-10,000 cps; less than 1.5% mid-band.

HUM AND NOISE: At least 60 db below rated output tap voltage.

OUTPUT IMPEDANCE SELECTION: Taps are selected by link change. Front panel tap select switches are available at additional charge.

INPUT SERVICE: Models rated 1KVA to 20KVA require 208/230 volts, 3 phase, 60 cycles. Larger models require 440/460/480 volts, 3 phase, 60 cycles—higher input voltages available on special order.

SIGNAL INPUT VOLTAGE: 1.0 volt RMS for rated output.

SIGNAL INPUT IMPEDANCE: 600 ohms, single ended.

KEYED OPERATION: All models are suitable for operation with keyed input signals.

METERING: All models include complete front panel metering. In addition, models rated at 5KVA to 200KVA have recessed front panel section with test points for critical circuit parameters—to keep down-time to a minimum.

PROTECTIVE CIRCUITS: CML instantaneous overload circuitry protects both amplifier and load. Rapid front panel reset permits return to normal operation with minimum down-time.

FINISH: Panels are satin green enamel; cabinets are green armorhide. Special colors are available on a custom basis.

VAPOR COOLING

All CML models rated at 30KVA output or higher feature modern vapor cooling systems to dissipate heat generated in the "final" amplifier. Use of this method, with its high efficiency heat transfer, reduces "raw water" requirements appreciably when compared with older "water cooled systems." In addition, it eliminates the need for a pump in the closed loop cooling system and greatly reduces contamination of distilled water in the closed system—thus greatly reducing maintenance.

CML

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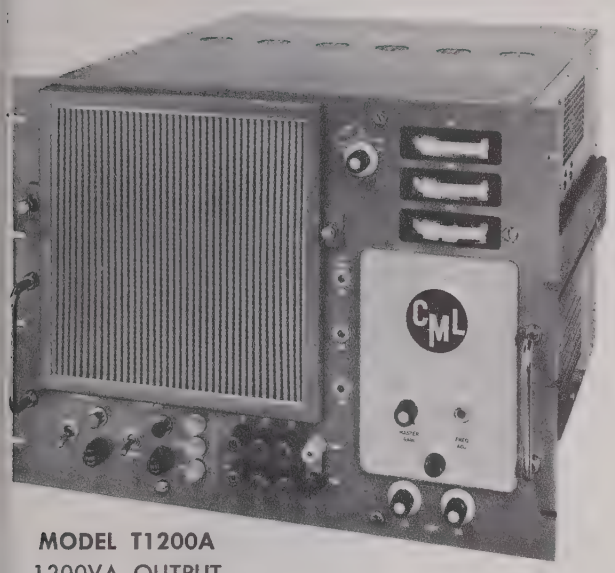
THREE PHASE FREQUENCY CONVERTERS

BULLETIN NO. TEC 65



MODEL T1200A
1200VA OUTPUT

THE *New* COMPACT "A" SERIES

AN OUTSTANDING COMBINATION of POWER, PERFORMANCE and PACKAGING

- **11 FREQUENCY CONVERTERS ARE AVAILABLE** . . . 30VA to 15KVA
- **MINIMUM PACKAGE SIZES** . . . 2500VA in 14" rack height; 500VA in 8¾" rack height
- **INTERCHANGEABLE PLUG-IN OSCILLATORS** . . . 16 standard oscillators are available—to provide fixed or adjustable output frequencies between 45 and 6,000 cps and stabilities to ±0.001%
- **INSTANTANEOUS OVERLOAD PROTECTION** . . . An overload of any one phase causes complete output shut-down, protecting 3 phase load
- **DUAL OUTPUT VOLTAGE FOR △ OR Y LOADS** . . . Adjustable voltages 0-125 volts line-to-line as well as 0-217 volts line-to-line are presented at output terminals; output is isolated for maximum versatility
- **CONSTANT VOLTAGE OUTPUT** . . . 0.5% regulation for no load to full load change—response time less than 50 microseconds
- **OUTPUT VOLTAGE UNAFFECTED BY UNBALANCED LOADS**

GENERAL INFORMATION

The new "A" series of Three Phase Frequency Converters are exceptionally versatile sources of AC power. Each converter consists of a regulated **THREE PHASE AMPLIFIER** with interchangeable fixed or variable frequency **PLUG-IN OSCILLATORS** for a wide range of precision AC power applications. The amplifier has a full power range of 45-6,000 cps. With the incorporation of a CML plug-in oscillator (which includes 120° phase shift network) precise fixed or adjustable frequencies are available anywhere within this range. Plug-in oscillators are Wein bridge or tuning-fork controlled for frequency stabilities ranging between ±0.25% and ±0.001%. Dual output taps are standard for matching either Delta or Wye loads (output may be connected either 120 volts line-to-line or 208 volts line-to-line). Precise amplitude stability and low harmonic content are provided by a combination of positive current feedback and inverse voltage feedback. With these combined features, the series A converters are versatile precision instruments designed to meet a vast number of applications from production checkout to R&D testing. Their rugged and compact construction makes them ideal for airborne and shipboard applications as well.

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Note!

STANDARD CML FREQUENCY CONVERTERS
consist of
THREE PHASE AMPLIFIER + PLUG-IN OSCILLATOR

THREE PHASE AMPLIFIERS

MODEL	3Ø OUTPUT POWER VA	INPUT	*DIMENSIONS H	W	D
T30A	30	115V, 1Ø, 47-65~	7	19	19
T150A	150	115V, 1Ø, 47-65~	7	19	19
T300A	300	115V, 1Ø, 47-65~	8¾	19	22
T500A	500	115V, 1Ø, 47-65~	8¾	19	22
T750A	750	208/230V, 3Ø, 47-65~	14	19	22
T1200A	1,200	208/230V, 3Ø, 57-65~	14	19	22
T1750A	1,750	208/230V, 3Ø, 47-65~	14	19	22
T2500A	2,500	208/230V, 3Ø, 47-65~	14	19	22
T5000A	5,000	208/230V, 3Ø, 57-65~	45	24	24
T10000A	10,000	208/230V, 3Ø, 57-65~	57	28	28
T15000A	15,000	208/230V, 3Ø, 57-65~	77	33	33

*30VA to 2500VA units are available as either rack mount or bench models with dimensions as shown above.
5000VA to 15000VA units are cabinet models including casters.

Plug-in OSCILLATORS

3Ø OUTPUT FREQUENCY	← FREQUENCY STABILITY → ±0.25%	±0.1%	±0.01%	±0.001%
	MODEL #			
Fixed 400 cps	SG-34A	SG-34B	SG-34E	SG-34G
Fixed 60 cps	SG-32A	SG-32B	SG-32E	Special Order
Fixed 50 cps	SG-31A	SG-31B	SG-31E	Special Order
Adjustable, 350-450 cps	SG-35A	SG-35B	X	X
Adjustable, 45-70 cps	SG-33A	SG-33B	X	X
Adjustable, 300-2,000 cps	SG-36A	X	X	X
Adjustable, 45-6,000 cps	SG-37A	X	X	X

SPECIFICATIONS—STANDARD FREQUENCY CONVERTER MODELS

OUTPUT CONFIGURATION: Three Phase, 4 wire wye, neutral floating.

OUTPUT VOLTAGE: 0-125 Volts line-to-line and 0-217 Volts line-to-line; both sets of terminals are presented at output. Full power available at output of 110-125 volts and 190-217 volts.

DUTY CYCLE: Continuous duty at full rated output.

OUTPUT POWER: Rated output power for each model is shown in chart above. Maximum power per phase is ⅓ of 3Ø output.

VOLTAGE REGULATION: Less than 0.5% for no load to full load change. ±0.5% for ±5% input voltage change.

LOAD POWER FACTOR: 0.7 lead or lag to unity at rated output; wider power factor range with slight derating.

UNBALANCED PHASE LOADING: Separate power amplifiers and regulation circuits are provided for each output phase. Therefore unbalanced phase loading has negligible effect as long as the rated output power per phase is not exceeded.

PROTECTIVE CIRCUITS: All models are equipped with instantaneous overload protection and front panel reset. An overload in any output phase causes all phases to shut down, thus protecting 3Ø loads. Front panel lamps also indicate which phase has been overloaded.

OUTPUT & INPUT TERMINATIONS: Output terminals are furnished both front and rear, five way binding posts on front, barrier strip on rear. Input is via rear mounted barrier strip.

FREQUENCY RANGE: Each amplifier model is rated at full power 45-6,000 cps; the operating frequency range is determined by the particular plug-in oscillator which is selected. Standard oscillator frequencies are tabulated above.

FREQUENCY STABILITY: Determined by the particular plug-in oscillator which is selected. Stabilities of standard oscillators are tabulated above.

RESPONSE TIME: Less than 50 microseconds.

WAVE SHAPE: Sine Wave.

HARMONIC DISTORTION: Less than 3% over the entire 45-6,000 cycle amplifier range; less than 1% mid-band.

HUM AND NOISE: 60 db below maximum output voltage.

OUTPUT PHASE SEPARATION: 120±1° for fixed frequency models as well as 350-450 cycle models. 120±2° for 45-70 and 300-2,000 cycle models. 120±3° for 45-6,000 cycle models.

METERS: Models rated 30VA to 500VA are furnished with output voltmeter and selector switch to monitor any line-to-line and line-to-neutral voltage. Models rated 750VA to 15KVA have three (3) combination output voltmeter/plate current ammeters with selector switch to monitor any line-to-line and line-to-neutral output voltage as well as plate current of 3Ø amplifier.

CONSTRUCTION: Standard Models rated 30VA to 2500VA are available in standard 19" rack mount configuration or as bench models. Both styles are furnished with complete dust covers. Side support is recommended for all rack mount models—slides are offered as optional accessories. Standard 5KVA to 15KVA models are furnished complete in cabinet enclosures with casters.

FINISH: Panels are satin green enamel; cabinets are green armorhide. Special colors are available on a custom basis.

ORDERING INFORMATION

All Standard Frequency Converters may be ordered directly from the catalog by specifying both the Three Phase Amplifier model and the Required Plug-in model (or models). Thus, a 500VA Frequency Converter having an output frequency of 350-450 cps with a frequency stability of ±0.1% is specified as a Model T500A Amplifier with Model SG-35B Oscillator.

When ordering models rated at 30VA to 2500VA please specify whether Rack Mount or Bench Model is required.

SEPARATE PLUG-IN OSCILLATORS: When ordering Plug-in Oscillators as separate items it is necessary to specify which Amplifier Model or Models the oscillator is to be used with. All oscillators for 30VA to 500VA Models are interchangeable. A second set of oscillators are interchangeable for all models between 750VA and 15KVA.

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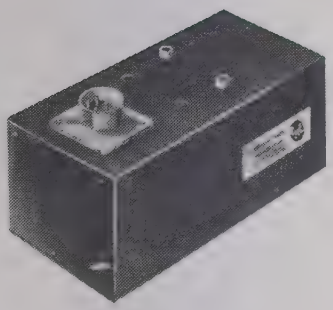
Transistorized DC to AC POWER INVERTERS

BULLETIN NO. DA67



MRS SERIES—60 Cycle Output
Voltage & Frequency Regulated.

MNS SERIES—60 Cycle Output
Frequency Regulated, Voltage Unregulated.

DRS SERIES—400 Cycle Output
Voltage & Frequency Regulated.

MRS Series—60 ~
Output: 115 Volts rms, Single Phase
Input: 22-30 Volts D.C.
Voltage & Frequency Regulation: 0.5%

Model	Output VA	Dimensions HxWxD	Net Wt. Lbs. (Approx.)
MRS-500	500	12"x14"x14"	150
MRS-1000	1000	14"x17"x19"	175
MRS-2000	2000	17"x17"x19"	300

MNS Series—60 ~
Output: 105/115/125 Volts rms, Single Phase
Input: 22-30 Volts D.C.
Frequency Regulation: 0.5%

Model	Output VA	Dimensions HxWxD	Net Wt. Lbs. (Approx.)
MNS-50	50	5"x11"x11"	28
MNS-100	100	5"x11"x11"	28
MNS-500	500	8"x14"x14"	80
MNS-1000	1000	14"x17"x19"	162
MNS-2000	2000	17"x17"x19"	280

DRS Series—400 ~
Output: 115 Volts rms, Single Phase
Input: 22-30 Volts D.C.
Voltage & Frequency Regulation: 0.5%

Model	Output VA	Dimensions HxWxD	Net Wt. Lbs. (Approx.)
DRS-52*	50	5"x11"x8"	25
DRS-50	50	5"x11"x8"	25
DRS-100	100	5"x11"x8	26
DRS-500	500	8"x14"x16"	70
DRS-1000	1000	14"x17"x18"	160
DRS-2000	2000	17"x17"x19"	290

*Input Voltage of Model DRS-52 is 10-14 Volts.

- 50 to 2000VA Output
- Low Distortion Sine Wave
- Highly Regulated
- Reliable
- Quiet Operation
- Overload & Short Circuit Protection
- Protected Against Input Polarity Reversal
- High Efficiency
- Input to Output Isolation
- No Auxiliary Cooling Required

CUSTOM REQUIREMENTS:

Modified or custom supplies which embody many techniques incorporated in the fine catalog units described above are also available on a relatively short term delivery basis. We invite your inquiries regarding **completely militarized** power supplies and those requiring special frequency/voltage configurations.

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SPECIFICATIONS:

Input Configuration: Two Wire, Isolated.

Output Configuration: Single Phase, Two Wire Isolated.

Output Voltage: MRS & DRS Models are preset at 115 Volts RMS. MNS Models have Taps available at 105/115/125 Volts RMS—These Values measured at nominal input voltage with Half Load.

Duty Cycle: Continuous Duty at Full Rated Output.

Harmonic Distortion: 1% for 400 Cycle Models, 3% for 60 Cycle Models when Powering Linear (resistive or reactive) Loads; Slightly Higher into Switching Type Loads.

Load Power Factor: 0.7 Lead or Lag to Unity at Rated Output; wider Power Factor Range with Slight Derating.

Frequency Regulation:
Load: 0.5% for No Load to Full Load Change.
Line: 0.5% for Rated Input Line Change.
Units providing Frequency Regulation and Stability to ±0.001% available on Special Order as are units in which the Frequency may be synchronized with an external source.

Voltage Regulation:
MRS & DRS Series:
Load: 0.5% for No Load to Full Load Change.
Line: 0.5% for Rated Input Line Change.

MNS Series:
Load: Approximately 6% for Half Load to Full Load Change.
Line: Approximately Proportional to Input Line Change.

Ambient Temperature:
Operating: —20°C to +50°C.
Storage: —40°C to +85°C.

Temperature Stability:
Frequency: Max. 0.05%/Degree C.
Voltage: MRS & DRS Series Max. 0.01%/Degree C.
MNS Series Max. 0.03%/Degree C.

Protective Circuits:
50 & 100 VA Models have input and output fuses. Input fuse will blow on application of input polarity reversal. 500 to 2000 VA Models have circuit breaker protection against overload, shorted output, DC overvoltage and overtemperature. Protection is also provided for DC polarity reversal.

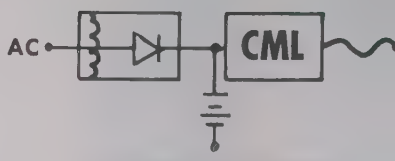
Cooling: CML Inverters require no auxiliary cooling. There is no need to provide special base plate heat sinks. Units rated at 500 to 2000 VA include quiet built-in fan.

Housing: Two Part Modular Housings with heat radiating finish.

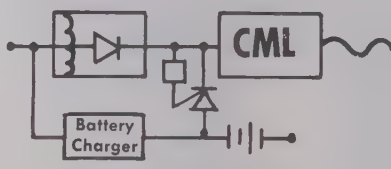
Mounting: Tapped Inserts are provided for Base Mount.

Input-Output Termination: 50 & 100 VA Models have quick disconnect on top surface. Mating Connector is furnished with inverter (Dimensions listed are plus connector). 500 to 2000 VA units have terminals accessible via removable top Cover Plate.

APPLICATIONS:



FLAME SENSOR & ALARMS
AIRCRAFT 60 CPS POWER
MARINE COMMUNICATIONS
FLUORESCENT LIGHTING



MICROWAVE SYSTEM AC
HOSPITAL EMERGENCY AC
PRECISION MOTOR SPEED
MOBILE INSTRUMENT AC

SONAR DRIVER UNITS
ASTRONAUT SUIT COOLING
TORPEDO GYRO DRIVE
FUEL CELL INVERTERS

CML Representatives and the Application Engineering Staff at the Home Office are always happy to discuss applications, to recommend particular types of Inverters, and to provide detailed test data under various operating conditions.

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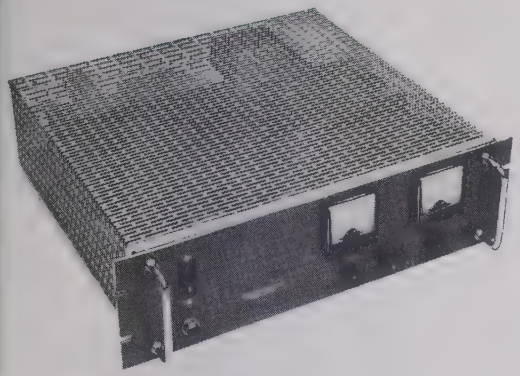
Solid State
FREQUENCY CONVERTERS

BULLETIN NO. SFC67



CRS SERIES—400~OUTPUT

OUTPUT

Voltage: Adjustable 105-125 volts, single phase

Voltage and Frequency Regulation: 0.5%

Harmonic Distortion: Less than 1%

Model	Output VA	*45-65 Cycle Input Single Ø Volts	Dimensions HxWxD
CRS-50	50	105-125	5¼x19x10
CRS-100	100	105-125	5¼x19x10
CRS-250	250	105-125	5¼x19x15
CRS-500	500	105-125	10½x19x16
CRS-1000	1000	105-125	15¾x19x16
CRS-2000	2000	210-250	2 sections, each: 15¾x19x18

*350-450 cycle input also available.

LRS SERIES—60~OUTPUT

OUTPUT

Voltage: Adjustable 105-125 volts, single phase

Voltage and Frequency Regulation: 0.5%

Harmonic Distortion: Less than 3%

Model	Output VA	**350-450 Cycle Input Single Ø Volts	Dimensions HxWxD
LRS-200	200	105-125	7x19x15
LRS-500	500	105-125	12¼x19x16
LRS-1000	1000	105-125	21x19x16
LRS-2000	2000	210-250	2 sections, each: 21x19x18

**45-65 cycle input also available.

CRS SERIES—400 CYCLE OUTPUT

LRS SERIES— 60 CYCLE OUTPUT

- **50 to 2000VA Output**
- **0.5% Voltage & Frequency Regulation**
- **Low Distortion Sine Wave Output**
- **Full VA into BOTH CAPACITIVE & INDUCTIVE LOADS**
- **High Efficiency Switched Mode Operation**
- **Adjustable Output Voltage**
- **Complete Overload & Short Circuit Protection**
- **Input to Output Isolation**
- **Provision for Frequency Synchronization**

CUSTOM REQUIREMENTS

Modified frequency converters are also available having the following features:

> Two Phase or Three Phase Output Configurations.
> Square Wave Outputs.
> Fixed Frequency Stabilities to ±0.001%.
> Adjustable Output Frequencies.
> Special Input and/or Output Voltages.
> Modular Housings.

Modified units, which embody the same proven techniques and reliability as the fine catalog models, are available on a short delivery basis.

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SPECIFICATIONS:

Output Configuration: Single Phase, Two Wire, Isolated.
Input Configuration: Single Phase, Two Wire, Isolated.
Output Voltage: Adjustable 105-125 Volts RMS.
Voltage Regulation:
Load: Within 0.5% for No Load to Full Load Change.
Line: ±0.5% for rated Input Line Change.

Frequency Regulation:
Load: Within 0.5% for No Load to Full Load Change.
Line: ±0.25% for rated Input Line Change.
Units providing Frequency Regulation and Stability to ±0.001% available on Special Order as are units in which the Frequency may be synchronized with an external source.

Harmonic Distortion: 1% for 400 Cycle Models, 3% for 60 Cycle Models when Powering Linear (resistive or reactive) Loads; Slightly Higher into Switching Type Loads.

Load Power Factor: 0.7 Lead or Lag to Unity at Rated Output; wider Power Factor Range with slight derating.

Ambient Temperature:
Operating: −20°C to +50°C.
Storage: −40°C to +85°C.

Cooling:
CML Frequency Converters require no auxiliary cooling. There is no need for special base plate heat sinks. Units rated at 500VA to 2000VA include quiet built-in fan.

Temperature Stability:
Frequency: Max. 0.05%/Degree C.
Voltage: Max. 0.01%/Degree C.

Construction:
Standard models furnished as rack mount equipment with full dust covers. Modified rack mount or modular supplies packaged in accordance with customer specification are also available.

Slides available on special order.

Controls & Meters:
All models include input circuit breaker and output voltage adjust. Output voltmeter and ammeter standard on all models. However units may be ordered without one or both meters.

Input & Output Terminations:
Output connections via 5-way Binding Posts on front panel (ground terminal included). Rear terminals available as option when ordering.

Input connections via barrier strip at the rear of unit.

DESIGN FEATURES:

The CRS and LRS SERIES of SOLID STATE FREQUENCY CONVERTERS, highly regulated and highly compact, feature electrical characteristics far exceeding those normally found in switching type Frequency Converters. All models are rated for continuous duty operation into leading as well as lagging power factor loads. CML Converters therefore provide the flexibility so often needed for systems applications, where the load may vary from capacitor-input-filters (leading power factor) to switching-regulators or motor loads (lagging power factor). CML's proprietary power filter designs provide low distortion sine wave. This feature, coupled with precise control of output frequency and voltage, is ideally suited for equipment calibration and gyro spin-motor applications.

Transistorized Power Stages
The power generating stages of all CML models utilize transistors exclusively, rather than Silicon Controlled Rectifiers, thereby insuring positive, controlled turn-off and turn-on characteristics—essential for reliable, continuous, non-interrupted operation into leading and lagging power factor loads as well as non-linear full-wave and half-wave switching loads. Sudden line and load changes do not cause power interruption.

Component Derating
Conservative design and component selection is typical of all CRS and LRS models. Semiconductors are derated by 50%, capacitors 25%, transformers 20%, and resistors 40% from manufacturers' published ratings for both steady state and transient worst case conditions.

Protective Circuits
All models rated at 200VA and above are protected against overload or output short circuit by a quick acting sensing-comparator circuit which continuously compares the output current with an internal standard. Upon the application of an overload in excess of a pre-set limit, the output voltage will immediately fall to zero. In the event of an internal fault, the input circuit breaker will trip. A front panel overload reset is provided.

50 and 100VA models include input circuit breaker and output fuse for protection against overload and internal fault.

All CRS and LRS models include complete over-temperature protection. If safe temperature limits are exceeded the output voltage will fall to zero. The output voltage automatically returns to its normal condition once the internal temperature returns within safe limits.

CML Representatives and the Application Engineering Staff at the Home Office are always happy to discuss applications, to recommend particular types of Frequency Converters and to provide detailed test data under various operating conditions.

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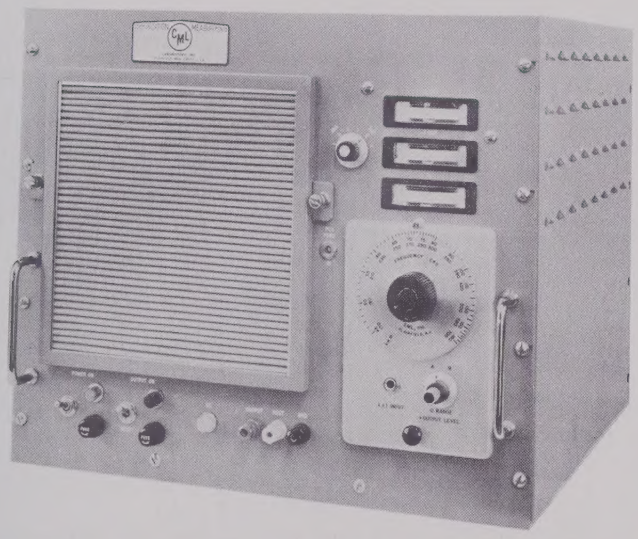
SINGLE PHASE AC POWER SUPPLIES

BULLETIN NO. EPS-65



Model N1000A
1000 VA OUTPUT

THE COMPACT "NA" SERIES

REGULATED POWER AMPLIFIERS with PRECISION PLUG-IN OSCILLATORS

- **8 POWER SOURCES ARE AVAILABLE** . . . 300VA to 15KVA
- **MINIMUM PACKAGE SIZES** . . . 2000VA in 14" rack height; 500VA in 8¾" rack height.
- **CONSTANT VOLTAGE OUTPUT** . . . 0.5% regulation for no load to full load change—response time less than 50 microseconds
- **EXCEPTIONAL VERSATILITY** . . . each Model can be operated either as a precision AC Power Supply or as an Audio Power Amplifier
- **INTERCHANGEABLE PLUG-IN OSCILLATORS** . . . 16 standard oscillators are available—to provide fixed or adjustable output frequencies between 45 and 6,000 cps and stabilities to ±0.001%
- **INSTANTANEOUS OVERLOAD PROTECTION**

The NA SERIES of AC POWER SUPPLIES are exceptionally flexible sources of audio power. Each power supply consists of a **REGULATED AUDIO POWER AMPLIFIER** with interchangeable fixed or variable **PLUG-IN OSCILLATORS** for a wide range of precision AC power applications. The Amplifier has a full power range of 45-6,000 cycles. With the incorporation of a **CML** Plug-in Oscillator precise fixed or adjustable output frequencies are available anywhere within this range. Plug-in Oscillators are Wein Bridge or Tuning Fork controlled for frequency stabilities ranging between ±0.25% and ±0.001%. Plug-in Oscillators also feature a front panel jack for external signal drive. Each Power Amplifier model may also be operated without a plug-in oscillator; however, in that case, the Model SA-2 External Signal Adapter is required.

Precise amplitude stability and low harmonic content are provided by a combination of positive current feedback and inverse voltage feedback. With these combined features, the Series **NA** Power Supplies are versatile precision instruments designed to meet a vast number of applications from Production Checkout to R&D testing. Their rugged and compact construction make them ideal for airborne and Shipboard applications as well.

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REGULATED POWER AMPLIFIERS

MODEL	OUTPUT POWER VA	INPUT	*DIMENSIONS H x W x D
N300A	300	115V, 1Ø, 47-65~	8¾ 19 22
N500A	500	115V, 1Ø, 47-65~	8¾ 19 22
N750A	750	208/230V, 3Ø, 47-65~	14 19 22
N1000A	1,000	208/230V, 3Ø, 57-65~	14 19 22
N1500A	1,500	208/230V, 3Ø, 47-65~	14 19 22
N2000A	2,000	208/230V, 3Ø, 47-65~	14 19 22
N5000A	5,000	208/230V, 3Ø, 57-65~	45 24 24
N15000A	15,000	208/230V, 3Ø, 57-65~	47 34 24

*300VA to 2000VA units are available as either rack mount or bench models with dimensions as shown above.

5000 VA and 15,000 VA units are cabinet models.

Model N5000A includes casters.

Plug-in OSCILLATORS

OUTPUT FREQUENCY	FREQUENCY STABILITY ±0.25%	±0.1%	±0.01%	±0.001%
	MODEL #			
Fixer 400 cps	SG-14A	SG-14B	SG-14E	SG-14G
Fixed 60 cps	SG-12A	SG-12B	SG-12E	Special Order
Fixed 50 cps	SG-11A	SG-11B	SG-11E	Special Order
Adjustable 350-450 cps	SG-15A	SG-15B	X	X
Adjustable 45-70 cps	SG-13A	SG-13B	X	X
Adjustable 300-2,000 cps	SG-16A	X	X	X
Adjustable 45-6,000 cps	SG-17A	X	X	X

All Plug-In Oscillators are provided with a jack for external signal drive.

	EXTERNAL SIGNAL ADAPTER
45-6,000 cps	Model SA-2

SPECIFICATIONS

OUTPUT CONFIGURATION: Single Phase, 2 wire floating.

OUTPUT VOLTAGE: Adjustable 0-125 Volts; full power available at output of 110-125 Volts.

DUTY CYCLE: Continuous duty of full rated output.

OUTPUT POWER: Rated output power for each model is shown in chart above.

VOLTAGE REGULATION: Less than 0.5% for no load to full load change. ±0.5% for ±5% input voltage change.

LOAD POWER FACTOR: 0.7 lead or lag to unity at rated output; wider power factor range with slight derating.

OUTPUT WAVE SHAPE: Sine wave. Less than 3% total harmonic distortion over the 45-6,000 cycle frequency range. Less than 1% mid-band.

RESPONSE TIME: Less than 50 microseconds.

HUM and NOISE: 60 db below maximum output voltage.

PROTECTIVE CIRCUITS: All models are equipped with instantaneous overload protection and front panel reset.

METERS: All standard models are furnished with front panel meters to monitor output voltage and plate currents of final amplifier tubes.

FREQUENCY RANGE: Each amplifier model is rated at full power 45-6000 cps with the exception of the Model N15000A which is rated at full power 200-6,000 cps. Each model may be driven from an external signal source over the rated frequency range. When driven by a PLUG-IN OSCILLATOR the output frequency range is determined by the particular plug-in which is selected. Standard oscillator frequencies are tabulated above.

FREQUENCY STABILITY: Determined by the plug-in oscillator or external signal source which is utilized. Stabilities of standard plug-in oscillators are tabulated above.

EXTERNAL SIGNAL: Signal input voltage of 5 volts rms required for full rated output. Signal input impedance 600 ohms, single ended.

OUTPUT & INPUT TERMINATIONS: Output terminals are furnished both front and rear, five way binding posts on front and barrier strip on rear. Input power termination is rear mounted barrier strip. Signal input is via jack mounted on front panel of plug-in oscillator or Model SA-2 External Signal Adapter.

CONSTRUCTION: Standard Models rated 300VA to 2000VA are available in standard 19" rack mount configuration or as bench model. Both styles include complete dust covers. Side support is recommended for rack mount models—Slides are available as optional accessories. 5KVA & 15KVA Models are furnished complete in cabinet enclosures. Standard Model N5000A is mounted on casters.

FINISH: Panels are satin green enamel; cabinets are green armorhide; special colors are also available on a custom basis.

ORDERING INFORMATION

Standard A. C. **POWER SUPPLIES** may be ordered directly from the catalog by specifying both the **POWER AMPLIFIER** model and the required **PLUG-IN OSCILLATOR** model (or models). Thus, a 1000VA Power Supply with an output frequency of 350-450 cps and a frequency stability of ±0.1% is specified as a Model N1000A Amplifier with Model SG-15B Oscillator.

When ordering a Power Amplifier without a Plug-In Oscillator, the Model **SA-2 EXTERNAL SIGNAL ADAPTER** is required in order to provide signal input jack and gain control.

Please specify whether Rack Mount or Bench Model is required when ordering Models rated at 300VA to 2000VA.

SEPARATE PLUG-IN OSCILLATORS: When ordering Plug-in Oscillators as separate items it is necessary to specify which Amplifier Model or Models the oscillator is to be used with. All oscillators for 300VA to 500VA Models are interchangeable. A second set of oscillators are interchangeable for all models between 750VA and 15KVA.

TWO-PHASE OPERATION

All standard amplifiers may be used in pairs to provide a 2 phase output. Special 2 phase **PLUG-IN OSCILLATORS** are available with a 90° phase separation. Please contact the factory or your CML Representative for a quotation on **TWO-PHASE PLUG-IN OSCILLATORS** tailored to your exact requirements.

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MP MASTER
MA30172